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Theoreticians, Artists and Artisans

Paul Feyerabend

ABSTRACT

The author discusses artists and scientists, comparing the similarities and differences of their activities and views. Providing examples of the ideas of philosophers through the ages, he uses various historical documents to support his analysis.

In Book VII of his *Republic,* Plato enumerates the subjects he thinks should be taught to the guardians of his ideal city—music, arithmetic, geometry and astronomy. Each subject has an important practical function. Music imparts harmony and grace, arithmetic aids generals in distributing their troops, geometry helps them to design fortifications and military camps, while astronomy is needed for orientation and the calendar.

According to Plato, music, arithmetic and geometry also have theoretical sides. Here numbers, lines and harmonies are related not to perceptions or material objects but to each other. The resulting structures form an unchanging objective world that stabilizes the mind and prepares it for grasping the idea of the Good. Compared with the knowledge that can be gained from contemplating this world, empirical information and practical skills are "base and mechanical" [1]. Yet, being "soldier[s] and philosopher[s] in one" [2], the guardians cannot disregard them.

The distinction between theories that are related to truth and observations or skills that are not—and the corresponding dichotomies real/apparent, objective/subjective, knowledge/opinion—became important ingredients of Western thought. This created problems for scientists who used research to explore what they regarded as a research-independent reality. Thus, as Max Planck writes,

> The two statements: "there exists a real external world that is independent of us" and: "the real external world cannot be known directly" are the two basic principles of all of physics. However, they are opposed to each other to a certain extent and thereby reveal the irrational element inherent in physics and in any other science [3].

Einstein's formulation is even more radical. "For us who are convinced physicists," he writes, "the distinction between past, present and future has no other meaning than that of an illusion, though a tenacious one" [4].

But how can experiments that are temporal processes and, therefore, "illusions" inform us about an illusion-free reality?

The idea that theory surpasses observation and practical skills is widespread. High-level theoreticians are better paid, more prominent and are thought to be wiser, more sexy, more profound than experimentalists or curve fitters. Who are the heroes of science freaks? Copernicus, Newton, Einstein, Hawking and now also Thom—there is not one experimentalist among them. (This changed with the increasing interest in biological and palaeontological matters—except that molecular biology again emphasizes theory.)

Even practical activities such as medicine and engineering were subjected to theoretical processing—the assumption being that theories give better results than a knowledge that is tied to memory and the reactions of the human body. In the 1960s, British and American engineering schools started replacing practical skills and empirical information by theory, and a hands-on approach by a top-down procedure, where theoreticians provided models for low-level practitioners without taking their experience into account [5]. Major failures, the *Challenger* catastrophe among them, and historical studies of scientific practice showed that theoreticians need artisans to connect them with the world.

Fig. 1. Illustration from Descartes's *L'homme* (Treatise of Man) (1664) [26].

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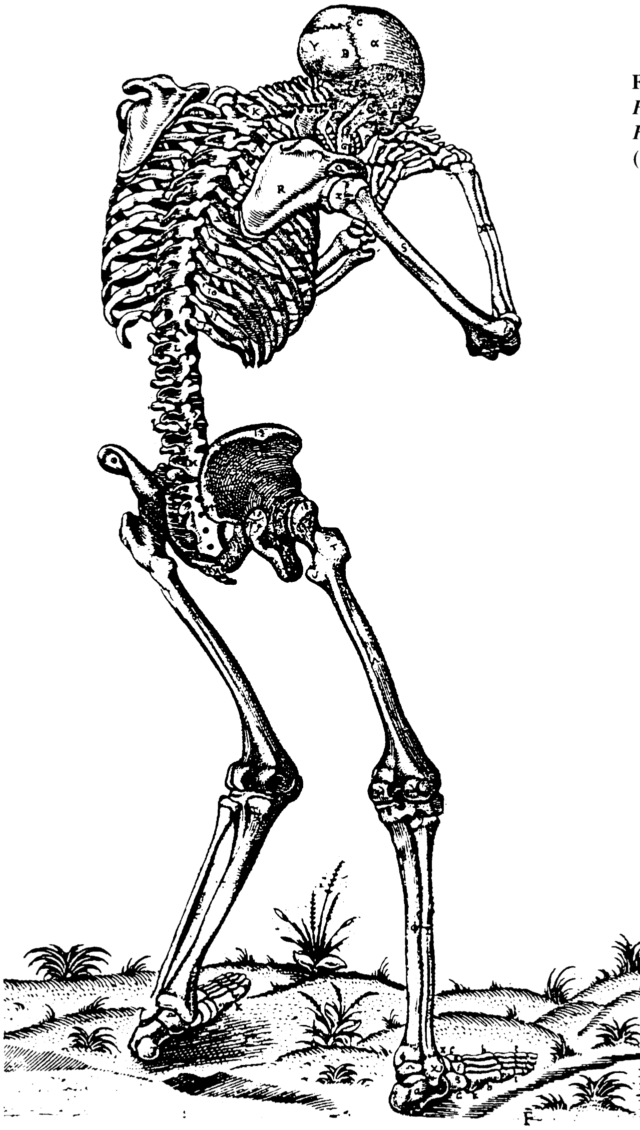

Fig. 2. Vesalius, *De Humani Corporis Fabrica*, Book I (1543) [27].

Note, incidentally, that an ideology that neglects artisan demands runs into difficulties no matter what its content. Some modern architects concentrated on aesthetics and demanded to be "relieve[d] from the burden of dealing with technical issues." Their evidence was almost entirely photographic and disregarded "the ancient and previously unavoidable techniques of personal inspection and measured drawing." Material failures, social failures (even the destitute did not want to live in the wonderful New Spaces provided for them), and cost overruns were the result.

General conflicts of the kind alluded to by Planck and Einstein—i.e. conflicts between a real but hidden world and a sham world that is accessible to humans—are found in all areas of human endeavor. In religion such conflicts are often resolved by revelation. Parmenides, the arch rationalist, went the same way: a goddess, not his own reason, explains the properties of Being. Scientists have grown rather fond of this procedure. Replacing alien divinities by their own unfathomable—and thus in a way still alien—minds, they introduced a special form of revelation that they called creativity. This brought a touch of class or an "aesthetic dimension" to what seemed to be a rather barbaric enterprise. The trouble is that science is supposed to be about something while creativity need not be. Plato's critique of the arts emphasizes precisely this point.

According to Plato, theoreticians find truth and artisans create useful objects. Artists do neither. A carpenter who tries to make a good chair takes his cue from a theoretical entity, the ideal chair. He creates an imperfect copy—matter resists in many ways—but at least he looks at the right object. A painter who tries to paint a chair sets his sights much lower. Concentrating on the material chair (which is already a bad copy of what a good chair should be), he imitates the way in which it appears when viewed from a certain direction. His product is not only useless (one cannot sit on it, one cannot put objects on it, etc.), it is also deceptive—the picture of a chair may be confused with a material chair. Even worse, the deception is not an accident, it is intended—clever painters use special tricks to make their product look like the real thing. *They intentionally replace reality by a chimera.*

Poets do the same. Homer talks about wars and the foundation of cities as if he were an expert in these matters. Many educators fell for him—his epics were

Fig. 3. (below) Paul Gauguin, *The Loss of Virginity*, oil on canvas, 35½ × 51¼ in, 1890–1891. (Photo courtesy of The Chrysler Museum of Art, Norfolk, Virginia, Gift of Walter P. Chrysler, Jr., 71.510)

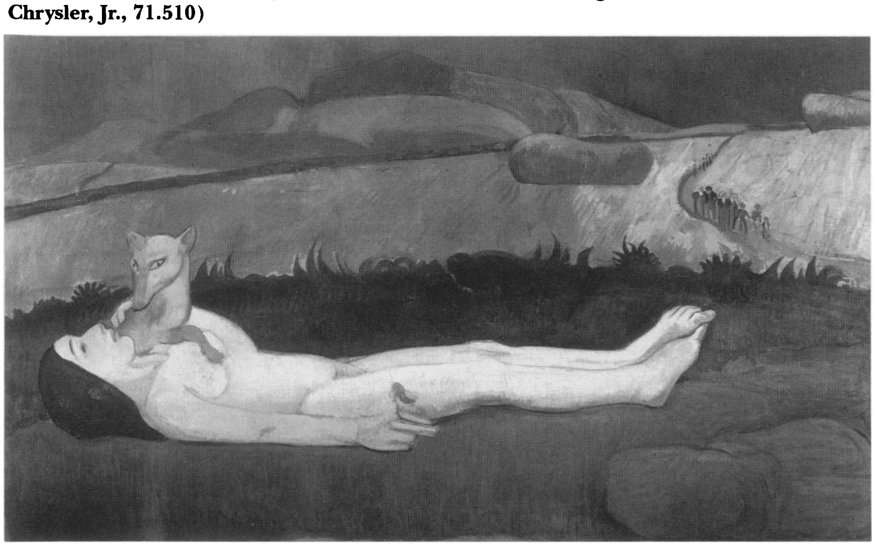

Fig. 4. Sexual therapy on the stage. Sex therapist Annie Sprinkle demonstrating to an audience that "a cunt has no teeth" on stage at the New York Avant Garde Theatre [28]. (Photo: Leslie Barany, courtesy of Annie Sprinkle)

the basis of education, in Athens and elsewhere. But, Plato asks Homer, "tell us what city was better governed because of you just as Lacedaemon was because of Lycurgus, and many other cities, great and small, because of other legislators? What city credits you with having been a good legislator and having benefitted them? Italy and Sicily say this of Charondas and we of Solon. But who says it of you?" [6] And he points out that no public service was ever credited to Homer. Here, then, is another imitator of secondary matters such as rumors and hearsay whose words confuse by their rhythm, meter and harmony but make a poor showing "when stripped bare of their music and read literally" [7].

The tragedians, finally, move the emotions, not the mind, and make their heroes behave in the most unseemly way. Result: painters and poets "set up in each individual's soul a vicious constitution by creating chimeras far removed from reality" [8]. But a city whose inhabitants rely on chimeras cannot survive. Artists, therefore, must be dismissed from harmonious communities [9].

Plato and his modern followers posit a gulf between the world of humans and an "objective" world that is independent of human thought and action. Humans can get in touch with the objective world. To do this they must trim their human nature and suppress large parts of human existence (the arts, popular forms of religion, etc.) Plato adds that even an empirical science cannot succeed: perception is imperfect, and observable phenomena depend on matter that by its inclination towards lawlessness conceals True Being.

But is it not strange to define reality in a manner that excludes basic human abilities and products? Is this not again anthropomorphism, though an anthropomorphism of a rather masochistic kind? Would it not be better to turn the argument around and to assume that skills, perceptions, the products of artisans and the objects most despised by Plato, the works of art that exist and have effects, are not opposed to Being, but are produced by it, either directly, or by way of creatures previously produced? Aristotle argued in this way. Many modern scientists are inclined to welcome the inversion—but they hesitate because of some remaining Platonic commitments. Let us therefore take a closer look at the matter.

The idea that artworks are products of reality (nature) was proposed by Goethe and elaborated by Schoenberg and von Webern. Commenting on Greek works of art in Italy, Goethe wrote (my paraphrase):

> The magnificent works of art are at the same time magnificent works of nature produced by humans in accordance with *true* and *natural* laws [10].

Goethe often returns to this topic, most frequently in his *Theory of Colors* and his *Proverbs in Prose.* For example:

> Color is lawful nature working in the organ of the eye [11]. . . . Human beings insofar as they make use of their healthy senses are the largest and most precise physical instruments that can exist and it is a great misfortune that modern physics [i.e. the physics of Goethe's time] as it were separated the experiment from the experimenter and now wants to . . . demonstrate what can be known about nature and even what she can achieve on the basis of artificial instruments alone [12]. . . . What is beautiful is a manifestation of hidden laws of nature which without the appearance of beauty would forever remain unknown [13].

Von Webern repeats and summarizes:

> Goethe does not recognize any essential difference between products of nature and artistic products; both are the same. What we . . . call a work of art is basically nothing but a product of general nature. . . . Humans are only the vessels which receive what "general nature" wants to express [14].

For Webern, accordingly, the history of (Western) music is the history of the gradual conquest of a naturally given material—the sequence of overtones. "Our major scale," Schoenberg had written in his *Harmonielehre,*

> the sequence c, d, e, f, g, a, b, c, whose elements were at the basis of Greek music and of the churchmodes, can be explained as having been found by imitating nature; intuition and combination then helped to reconstruct the most important properties of a tone, namely the sequence of its overtones which we imagine as being situated simultaneously in the vertical in such a way that it now fills the horizontal, no longer simultaneously, but one overtone sounding after another [15].

Why do artworks look so different from galaxies, planets and living organisms? Well, not all of them do. Figure 1, which is an illustration from Descartes's essay *L'homme* [16], looks like a surrealist drawing; Fig. 2, one of the illustrations of the first anatomical treatise in the West [17], looks like a candidate for an exhibition of Romantic Art. Figure 3, a genuine painting, presents to us an attitude towards women and chastity and it does this better and more directly than any sociological analysis. Figure 4 is rather complex—it is a record (= science) of a theatrical performance (= art) trying to demonstrate a procedure (= artisanry) deriving from a theory (= science) about human behavior. Computer art and computer simulations cannot always be separated and many scientific illustrations look like artworks (Fig. 5). Still, there are objects that make the question a sensible one. The answer is that, given special conditions, the laws of nature produce special results. Given different conditions Newton's laws can produce falling objects, the tides, circling planets, stellar stability, cosmic oscillations or chaos. In the past, the different behavior of stars and stones led to the assumption that nature was divided into two large domains—one reaching from the surface of the earth to the moon, and the other from the moon to the fixed stars. The leaders of modern science showed how *a single set of laws,* working under different conditions, *can produce qualitatively different results.* Goethe suggests that the difference between artworks and rocks be explained in the same way: the growth of rocks does not involve humans while artworks do.

One consequence of Goethe's idea is that individual creativity is considerably reduced.

If artworks are natural products then, like nature, they will change—new forms will appear but without major contributions from isolated and "creative" individuals. *It is nature as it manifests itself in a particular person that shows the way, not a mysterious additional "creativity."* Or, as Ernst Mach wrote about mathematical inventions:

> It is often the case that numbers are called "free creations of the human mind." The admiration for the human mind which is expressed by these words is quite natural when we look at the finished, imposing edifice of arithmetic. Our understanding of these creations is however furthered much more when we try to trace *their instinctive beginnings* and consider the circumstances which produced the need for such creations. Perhaps we shall then realize that the first structures that belong to this domain were unconscious biological structures which were *wrested from us* by material circumstances and that their value could be recognized only after they had appeared [18].

Counting behavior and the abstract idea of numbers are results of a complex interaction between humans and their habitat.

Following Goethe, we must also admit that human efforts and human products are much closer to each other than the usual Platonic subdivisions suggest. For example, it makes sense to speak of scientific styles and fashions giving rise to a great variety of products. It turns out that science is indeed composed of divergent procedures and correspondingly divergent results.

Thus we have scientists who tie research to events permitting "strong inferences" and favor "predictions that will be strongly supported and sharply rejected by a clearcut experimental step" [19]; and other scientists who find it "strange that human beings are normally deaf to the strongest arguments while they are always inclined to overestimate measuring accuracies" [20].

Note that the difference has nothing to do with the fact that Luria deals with terrestrial matters and that Einstein is discussing global cosmic laws. Militant empiricists have invaded cosmology (examples: Curtis, Ambarzumjan, Arp) while high-level theoreticians are changing zoology and anthropology. And there are still further assumptions about the relation between theory, observation, experiment and the practices that embody them: *science does not contain one style of research, it contains many.* This is a first and rather obvious point of contact between technology, the sciences and the arts. It is much more substantial than the vague and soggy talk about "scientific creativity."

A second point of contact is that *following their different styles of research, scientists have developed different views about the world that surrounds us.* In his survey *A History of European Thought in the 19th Century* (first published 1904–1912), Johann Theodor Merz [21] discusses the following views:

- *the astronomical view,* which used and refined action-at-a-distance laws and extended them to electricity and magnetism. Laplace's theory of capillarity was an outstanding achievement of this approach.
- *the atomic view,* which played a role in chemical research (example: stereochemistry) but was also opposed, for empirical as well as for methodological reasons.
- *the kinetic and mechanical view,* which employed atoms in the area of heat and electrical phenomena. For some scientists, but by no means for all, atomism was the foundation of everything.
- *the physical view,* which tried to achieve universality on the basis of general notions such as the notion of energy. It could be connected with the kinetic view, but often was not. Physicians, physiologists and chemists like Mayer, Helmholtz, du Bois Reymond and Liebig were representatives in the nineteenth century, while Ostwald, Mach and Duhem extended it into the twentieth.
- *the morphological view,* which studied natural objects in their habitat and described them as they appeared to the attentive observer.

Merz also describes *the genetic view, the psychophysical view, the vitalistic view* and the *statistical view,* along with their procedures and findings.

The phenomenological view, not mentioned by Merz, is related to the physical view but is less general. It was adopted by scientists such as Lamé, who found that it provided a more direct way to

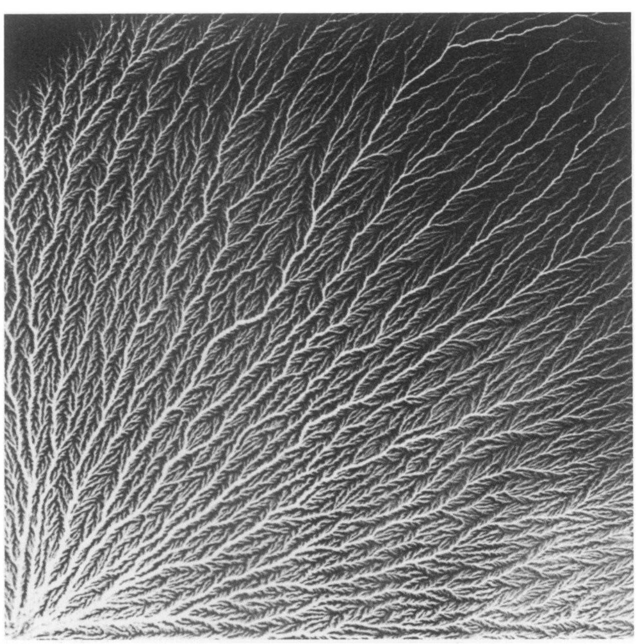

Fig. 5. Pattern of electrical breakdown in a plate of transparent lucite charged by ion implantation and discharged through a single point. (Photo courtesy of Bernard Vonnegut)

theory (elasticity, in the case of Lamé) than the use of atomic models.

Only a few of these views are based on simple description. Most of them involve intellectual and physical manipulations. Ancient atomism was almost entirely an intellectual exercise that replaced common talk by theoretical accounts but tried to hide the change behind a down-to-earth terminology [22]. The theoretical element remained strong in the nineteenth century—and some physicists knew it (example: Maxwell's calculation of the viscosity of gases). Twentieth-century high-energy physics interferes theoretically and materially. Some experiments (the experiments leading to the discovery of the W and Z particles, and the experiments to be carried out at the Fermi National Accelerator Laboratory) use large scale industrial plants (Fig. 6). Elementary particles are manufactured, not found. The idea that the products of violent procedures that are described in unusual terms with a complex history behind them existed before and independently of the procedures and the history was once regarded as the basic postulate of scientific research. This idea cannot be upheld.

Fig. 6. Fermi National Accelerator Laboratory, Batavia, Illinois. (Photo courtesy of Fermilab Visual Media Services)

We do not need to turn to quantum mechanics to argue this point. *Neither the technical features of science nor the common ways of speaking that surround them can be detached from the things described.* Lacking their complex conceptual equipment, scientists would not come closer to "reality"—they would be disoriented and incapable of understanding the simplest piece of apparatus. Experimentalists are tied to their equipment as a race car driver is tied to his car—they drive it in a fashion that involves "tacit" skills over and above any explicit theoretical knowledge they may possess; they "feel," as it were, what their equipment can do. Performing in their different styles and using different languages and skills, scientists produce results that often coagulate into entire but mutually exclusive worlds. Again, these worlds cannot be detached from the languages or the methods used—they are as intimately connected to them as the value of a quantum mechanical magnitude is connected to the measurement that determined it [23].

Extending this point of view to non-scientific cultures that do not invariably fail but provide their members with material and spiritual nourishment and a corresponding body of information, we arrive at the assumption that what we find when applying material, social, literary technologies to Being are not the structures and properties of Being itself, but the ways in which Being reacts to human interference [24]. The reactions may be benevolent—then we have a whole world welcoming the intruders. On the other hand, they may lead to disaster—although lacking any information about the Nature of Being itself, it will be impossible to explain why. (The assumption, therefore, differs from relativism.) In a way, individual scientists, scientific movements, tribes, nations function like artists or artisans trying to shape a world from a largely unknown material, Being. And just as stone permits the construction of artworks vastly different in appearance (as an example, compare the Pantheon with a Gothic Church), in the same way Being permits the construction of different *manifest worlds,* as I shall call them. Or, *researchers are artists who, working on a largely unknown material, Being, build a variety of manifest worlds that they often, but mistakenly, identify with Being itself.*

Let me add that the evaluation of manifest worlds (or the evaluation of the theories and the research programs that give rise to them) is not a simple matter. Ancient atomism constituted a manifest world that was largely intellectual (or, after Epicurus, social) and suffered from purely intellectual difficulties (though Aristotle had some quasi-empirical counter arguments). By the nineteenth century there were successes side by side with decisive failures: the manifest world of atomism had major cracks. But atomists, such as Abbot Suger and the architects of the early Gothic style [25], were not deterred. They changed their procedures, closed the cracks and almost succeeded in eliminating all drafts. Altogether the construction of manifest worlds is a long-lasting process, and the results are more like happenings than the stable museum pieces, textbooks and popular accounts call the achievements of science. The idea, however, that humans can penetrate the Mind of God is as laughable as would be the belief of intestinal bacteria that they had discovered the true nature of Being—and that it was fecal.

I conclude with a thought experiment, described by J. A. Wheeler, which reeks of High Science and may therefore be more impressive than the qualitative considerations I have just given. There exists a quasar that lies precisely behind a galaxy. The light of the quasar is bent by the gravitational lens surrounding the galaxy. It reaches the observer on two paths, a and b. If observers look in the direction of a, then they know that the light went along this one path without any interference with b. In this case, a and b are not "in phase." If, however, the observers make a and b interfere, then from the moment the interference pattern arises they know that the two paths, which are billions of light years long, are in phase. Thus the nature of processes extending billions of lights years in space depends on what observers are doing here and now.

References and Notes

1. Plato, *The Republic,* Book 7, line 522b5f.

2. Plato [1] line 525b7f.

3. Max Planck, "Positivismus und Reale Aussenwelt," *Vortraege und Erinnerungen* (Stuttgart: 1949) p. 234.

4. Albert Einstein, *Correspondance avec Michele Besso* (Paris: 1979) p. 312; see also p. 292.

5. H. Simon, *Models of My Life* (New York: Basic Books, 1991) p. 257f. E.S. Ferguson, *Engineering and the Mind's Eye* (Cambridge, MA: MIT Press, 1992); Ch. 7 includes a discussion of some of the resulting failures. Examples of historical studies alluded to in this text are found in Ian Hacking, *Representing and Intervening* (Cambridge: Cambridge Univ. Press, 1983) and Peter Galison, *How Experiments End* (Chicago, IL: Univ. of Chicago Press, 1987); further examples are discussed in A. Pickering, ed., *Science as Practice and Culture* (Chicago, IL: Univ. of Chicago Press, 1992). For the absolutism of modern architectural theory and its consequences, see R. Mark, *Light, Wind and Structure* (Cambridge, MA; MIT Press, 1990) (the quotations are from pp. 12 and 13); and Tom Wolfe, *From Bauhaus to Our House* (New York: Farrar, Strauss & Giroux, 1981).

6. Plato [1] line 599d7ff.

7. Plato [1] line 601a6ff.

8. Plato [1] line 605b8ff.

9. Plato [1] line 607b1ff.

10. J.W. Goethe, *Naturwissenschaftliche Schriften,* Vol. 5, R. Steinger, ed. (Dornach: 1982) p. 347 (Goethe's emphasis).

11. See Goethe [10] Vol. 3, p. 88.

12. See Goethe [10] Vol. 5, p. 351.

13. See Goethe [10] Vol. 5. p. 494.

14. A. Webern, *Der Weg zur Neuen Musik* (Vienna: 1960) p. 10f.

15. A. Schoenberg, *Harmonielehre* (Vienna: 1922).

16. R. Descartes, *L'homme* (Treatise of Man), Thomas Steele Hall, trans. and comm. (Cambridge, MA: Harvard Univ. Press, 1972) p. 81. (Originally published in 1664.)

17. A. Vesalius, *De Humani Corporis Fabrica I* (1543), Posterior view of skeleton. Republished as *The Illustrations from the Works of Andrea Vesalius of Brussels* (New York: Dover, 1950).

18. E. Mach, *Erkenntnis und Irrtum* (Leipzig: 1917) p. 327.

19. S.E. Luria, *A Slot Machine, A Broken Test Tube* (New York: 1985) p. 115.

20. A. Einstein, *The Born-Einstein Letters* (New York: 1971) p. 192. More detailed information about the variety of scientific styles is found in my contribution to the Erasmus Symposium of 1992, *Physics and Our View of the World,* L.J. Hilgevoord, ed. (Cambridge: Cambridge Univ. Press, 1994).

21. J.T. Merz, *A History of European Thought in the 19th Century* (Peter Smith).

22. Kurt von Fritz, *Philosophie und Sprachlicher Ausdruck bei Demokrit, Platon und Aristoteles,* Reprinted Ed. (Darmstadt: Wissenschaftliche Buchgesellschaft, 1966).

23. For this analogy, see Niels Bohr, "Natural Philosophy and Human Cultures," *Nature* **143** (1939) pp. 269ff.

24. Cultures or special groups such as particular scientific schools are tied to their surroundings by linguistic, social and material interventions. The term "technology," which emphasizes that we are dealing with occasionally rather violent interventions, was used by S. Shapin and S. Shaffer in their *Leviathan and the Air Pump* (Princeton, NJ: Princeton Univ. Press, 1985) pp. 25, 76ff.

25. See Otto von Simson, *The Gothic Cathedral: Origins of Gothic Architecture and the Medieval Concept of Order* (Princeton, NJ: Princeton Univ. Press, 1973).

26. See Descartes [16].

27. See Vesalius [17].

28. See *Stern* **34** (1990); and A.P. Duerr, *Obszönität und Gewalt* (Frankfurt: 1993) p. 533.